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Use of Anti-corrosion and Anti-fouling Paints Based on Coal Tar or its Mixtures With Phenol or Epoxy Resins

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Coal tar and varnish based on coal tar are widely used in paints for protection against corrosion on the submerged parts of ocean-going and river boats (1-3), underwater structures and underground pipe lines (4). This is due to their cheapness, ease of application to a surface that has been roughly prepared or which bears patches of other paints and their significant durability against the effects of sea and fresh water. However, paints made with only coal tar as the binder (or a varnish based on it), dry out comparatively slowly and form coatings which are susceptible to the effects of ultraviolet rays and to oils. The mechanical and physical properties of the coatings alter greatly in the process of aging.

The durability of coatings based on varnish or tar can be increased considerably by adding layering pigments to them, for example, aluminum powders or a mixture of tar with various natural or synthetic resins (5-18).

We conducted experiments for the purpose of comparing the properties of paints based on pure coal tar or varnish and those based on their mixtures with phenol or epoxy resins. As raw material we used varnish of the "Naval" grade (GOST 1709-50) with viscosity of 150 sec according to VZ-4, medium temperature tar (GOST 1038-41), phenol-formaldehyde resin no. 101 (TU MKhP 4137-53) and epoxy resin ED-5.

Tests were done on anti-corrosive paints C-ST-28-21 (coal tar varnish with aluminum powder), KF-11 (blend of coal tar with phenol resin, plasticizer and aluminum powder) and EV-1 (coal tar varnish, epoxy resin polyethlene polyamine as a congealer), as well as anti-fouling paints NP-2 based on tar with medium melting temperature, and rosins, pigmented copper oxide and organic toxins. Test data are given in Table 1.

It can be seen from table 1 that the lowest rigidity and excellent elasticity is found in a coating of the paint C-ST-28-21. A coating of the anti-fouling paint NP-2 proved to be the best for hardness and the worst for impact strength.

Table 1

Physico-Mechanical Properties of Tested Paints

Name of Paint (Brand)	Viscosity, re VZ-4 at 18-23°C sec.	Comp. Dry hrs.	Rigidity by Inst. M-1 (in ref. to Glass) after:			Plasticity by Inst. SHG (mm) after: (days)			Impact Strength by inst. U-1 (kg.cm after: (days)		
			3 day	10 d.	30 d.	3	10	30	3	10	30
C-BT-28-21											
KF-11.....											
KF-V.....											
EK-1.....											
NB-2.....											

Note: The "K-1 coating drys after ten days at 16-20°C, but it becomes fully hardened only after 10-12 days. At lower temperature it is even slower and ceases completely for practical purposes at 5°C.

coating of the paint KF-V gave excellent indexes for elasticity and impact strength and was entirely satisfactory for rigidity. The rigidity of a coating of the epoxy-coal tar paint EK-1 increased significantly after 30 days, but at the same time its elasticity was lowered.

Addition of phenol or epoxy resins to coal tar or varnish significantly increases the rate of drying of paint layers. All the paints listed in table 1 have much dry residue; they may be applied over phosphatizers. The thickness of an eight-layer coating comes to approximately 450 microns.

The paint EK-1 made (according to a new formula) with addition of solvents in small quantities forms a single-layer approximately 100 microns thick.

The oil resistance of paints was determined by the change in the external appearance of the coating after it had stood in petroleum for a month. It was also determined that the paints C-PI-26-21 and NP-2 have unsatisfactory oil resistance, KF-11 and KF-V have satisfactory oil resistance, while EK-1 has extremely good oil resistant qualities. Laboratory tests of coatings in tap water and in 3% salt solution showed that in the given mediums these paint coatings have excellent protective properties (table 2).

For the purpose of showing the degree of distribution of corrosion during mechanical damaging of the paint layer through to the metal, tests were conducted on a system of varnish-paint coatings based on various layer-formers. For this purpose, painted steel samples measuring 100 X 50 mm were taken and the coating removed over a 1 sq cm area, after which the samples were tested in fresh water and in a 3% salt solution. Test results are given in table 3.

A coating of paint C-PT-26-21 was also tested under conditions of cathode shielding for 250 days (coating thickness 220-260 microns); positive results were obtained. Bench tests of coating systems of anti-corrosive paints C-PT-26-21, EK-1, KF-V and KF-11, anti-fouling paints 79 opk, KMS-79 and VVV-53, as well as the anti-fouling paint NP-2 applied over ethanol paint VYKhS-40 were conducted on a stand in the Black Sea (in the vicinity of Sevastopol and Yukhime) during one or two summer seasons.

The tests confirmed that the paints C-PT-26-21, EK-1, KF-11 and KF-V have high anti-corrosive properties. The anti-fouling paint NP-2 proved to be ineffective (fouling was detected on 30-40% of the coating surface after one year). Excellent results were obtained with the anti-fouling paint 79 opk.

Table 2

Results of Tests of Coating Systems in Fresh Water and in 3% Solution of Sodium Chloride

Coating System	Thickness microns	Duration months	Appearance after testing in water	Appearance after testing in 3% NaCl solut.	Adhesion after test in fresh water	Adhesion after test in 3% NaCl solution
4 layers of paint, O-RT-28-2I + I layer tar varnish + I layer paint B-I + I layer paint 79p	--	54	no change	no change	satisfactory	satisfactory
6 layers O-RT-28-2I + 2 layers 79ppk	180-200	I9	same	same	same	same
6 layers KF-V + 2 layers 79ppk	200-240	2I	"	cracks seen	"	"
6 layers KF-II + 2 layers anti-fouling paint KhS-79	500	2I	---	"	--	"
6 layers EK-I + 2 layers 79ppk	400-450	2I	no change	no change	excellent	excellent
6 layers EK-I + 2 layers anti-fouling paint KhS-79	400-475	2I	same	hair-like cracks after I7 mos.	same	same
I layer Phosphatizing primer V1-022 + 5 layers EK-I + 2 layers anti-fouling paint KhS-79	330-360	2I	"	same	"	"

Note: Paint B-I is an anti-corrosive paint based on polyvinylbutyral; 79p is a paint of the KhS-79 type based on perchlorovinyl resin; 79ppk is an anti-fouling paint based on tar varnish, colophony and synthetic resins. In no case was a trace of corrosion detected on the metal.

Table 3

Results of Tests of Various Coating Systems with Damaged Areas in Fresh Water and in 3% Sodium Chloride Solution

Coating System	External appearance of coating after 6 months in water or solution	
	in water	in 3% NaCl solution
6 layers EKZhS-40 + 2 layers anti-fouling paint KhS-79.	Coating preserved without change. Adhesion excellent.	Coating preserved without change. Adhesion excellent.
6 layers O-BT-28-2I + 2 layers anti-fouling paint Kh-53.	same	same
1 layer phosphatizing primer VL-022+ 4 layers PL-72I+ 2 layers KCh-528	"	Peeling of film near damaged areas. Spot corrosion detected under film.
1 layer phosphatizing primer Vl-022+ 4 layers Kh-720 cinnamate +2 layers anti-fouling paint KhS-79.	"	Weakened adhesive strength around damaged parts. Traces of corrosion under film not detected.

Note: PL-72I is a butylphenol paint. KhS-720 is a cinnamate anti-corrosion paint based on the copolymer A-15-0. KCh-528 is an anti-fouling paint based on butylrubber. EKZhS-40 is an ethanol paint pigmented with iron oxide.